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MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS, BIG HILL CREEK RESERVOIR, BIG HILL CREEK, KANSAS

Public Health Service
Dallas, Texas

July 1960

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MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

BIG HILL CREEK RESERVOIR

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KANSAS

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In Cooperation with the

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U. S. Army Engineer District - Tulsa, Oklahoma

JULY 1960

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TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF MAPS	iv
I. INTRODUCTION	
Purpose of Study	1
Authority for Study	1
Acknowledgments	2
II. SUMMARY AND CONCLUSIONS	3
III. DESCRIPTION OF AREA	5
IV. ECONOMICS AND POPULATION	6
V. PRESENT WATER SUPPLIES	
Coffeyville	8
Parsons	9
Cherryvale	10
Altamont	10
Edna	11
Mound Valley	11
Ground Water	11
VI. FUTURE WATER NEEDS AND POTENTIAL SOURCES	13
Coffeyville	13
Parsons	13
Cherryvale	15
Smaller Communities	15

TABLE OF CONTENTS (Continued)

Page

VII. WATER QUALITY CONSIDERATIONS. 16

VIII. VALUE OF STORAGE. 21

BIBLIOGRAPHY 22

LIST OF TABLES

		Page
Table 1.	Populations - Present and Future	7
2.	Water Consumption - Coffeyville, Kansas.	8
3.	Water Use - Parsons, Kansas.	10
4.	Projected Water Requirements	14
5.	Water Quality - Big Hill Creek at Cherryvale, November 16, 1958.	16
6.	Water Quality - Verdigris River, Independence, Kansas	19
7.	Water Quality - Neosho River, Parsons, Kansas. . . .	20

LIST OF MAPS

Following Page

Map 1. Big Hill Creek Watershed Map 5

I. INTRODUCTION

Purpose of Study

The Committee on Public Works of the House of Representatives, United States, requested that the Board of Engineers for rivers and harbors review the reports on the Verdigris River, Kansas, submitted in House Document No. 440, 76th Congress, and other pertinent reports with a view of determining whether or not it is advisable to construct a reservoir on Big Hill Creek, a tributary of the Verdigris River, for flood control, water supply storage, and other allied purposes. This report is concerned with the determination of the need of providing municipal and industrial water supply in the proposed reservoir.

Authority for Study

By agreement with the District Engineer of the Tulsa District, U. S. Army, Corps of Engineers, the Public Health Service was requested to study the municipal and industrial water supply situation in relation to the proposed Big Hill Creek reservoir. This agreement is in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and Department of Health, Education, and Welfare, pertaining to the Water Supply Act of 1958, Title III of Public Law 85-500.

Acknowledgments

The municipal officials of Coffeyville, Parsons, Cherryvale, Altamont, Mound Valley, and Edna supplied valuable information on water consumption and capacities of existing facilities. The State Water Resources Board and the State Health Department of Kansas assisted in furnishing data on municipal and industrial water demands. Stream discharges and water quality data were obtained from the U. S. Geological Survey. The cooperation and assistance of each of the above is gratefully acknowledged.

II. SUMMARY AND CONCLUSIONS

1. The Big Hill Creek reservoir is located in southeast Kansas on Big Hill Creek, which is a tributary of the Verdigris River.

2. The population in the Big Hill Creek area has shown a slight decrease, due to an increased mechanization of farm operations, the transfer of railroad roundhouse operation, and the curtailment of military production.

3. Population trends are expected to reverse to a moderate increase with the assurance of more adequate water supplies for industrial and municipal purposes.

4. Neither municipal nor industrial wastes are discharged into Big Hill Creek. Some brine solutions find their way into the creek, but as 90 per cent of these wastes are now being reinjected to the oil-bearing strata and with the continuance of the very active state pollution control program, the quality of water in Big Hill Creek should steadily improve until its salt content will be less than 20 parts per million.

5. There is a need for storage to improve the dependability of water supplies in the area. Projected water needs (in addition to present sources of supply) in the Big Hill Creek area are 8.8 million gallons per day. Part of this requirement can be advantageously obtained from the Big Hill Reservoir. Corps of Engineers studies indicate an optimum yield of 4.5 mgd from the project.

6. The value of storage for M & I water supply in Big Hill Reservoir, for a yield of 4.5 mgd, is 5.8 cents per 1,000 gallons. This value is based on present day costs of building a single-purpose water supply dam at the same site as proposed for the Big Hill Reservoir.

III. DESCRIPTION OF AREA

The Big Hill Creek watershed lies within Neosho, Labette, and Montgomery counties, and is in the extreme southeastern portion of Kansas. General features of the watershed and contiguous areas are shown on Map 1. The watershed is about 25 miles long and has a maximum width of five miles, containing 110 square miles of wooded, hilly, and rolling terrain.

The stream rises near Thayer, Kansas, and flows to the south some 57 miles to enter the Verdigris River about one mile north of Coffeyville, Kansas. The stream bed slope varies from about 5.5 feet per mile in the upper three-quarters of its length to about 1.5 feet per mile in the lower regions. In the upper reaches, the stream channels range from 10 to 15 feet in depth, averaging 75 feet in width, and in the lower reaches, the channel varies from 15 to 25 feet in depth with a top width of 40 to 90 feet. The principal tributaries are Potato Creek and Wildcat Creek with confluences on Big Hill Creek, approximately at river miles 6 and 30.

Weather Bureau records at Independence, Kansas, about 12 miles from the reservoir site, indicate the average annual rainfall in the area to be 39 inches, ranging between a high of 54.6 inches in 1915 and a low of 21 inches in 1952.

BIG HILL CREEK
WATERSHED MAP
U.S. DEPARTMENT OF
HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS
LEGEND
SCALE OF MILES

IV. ECONOMICS AND POPULATION

The basic industry of the area is agriculture with concomitant processing plants and commercial and service establishments. In addition, some mining and petroleum production is carried on.

Employment in the area has experienced a net decrease. In agriculture the national pattern of requiring less labor to obtain the same volume of production has prevailed. There has also been a reduction in non-agricultural employment. The Kansas Ordnance Plant, located three miles from Parsons, Kansas, dropped from a peak employment of 7,500 during World War II to only a small maintenance crew. The M. K. & T. Railroad roundhouse and repair operation was shifted out of this area from Parsons to Denison. A marked decline in mining operations east of Parsons has cut employment in mining in that area to less than 500 persons.

The Kansas Ordnance Plant, located just east of Parsons, has been selected as one of the plants for reactivation in the production of solid fuel rocket propellant. With the reactivation of this plant, there should be a reversal of the downward trend in employment. This plant may employ 500 to 1,000 persons. The reactivation of this plant should also induce other employment.

The population trend has been downward in the two counties in the study area, decreasing approximately 10 per cent during the last thirty years. The decline has been similar for both rural and urban

areas. This is to be expected because of the loss in employment of both agricultural and nonagricultural industries.

The municipalities in this area are expected to demonstrate a reversal of recent population trends. With the abundant water that could be assured from the Big Hill Reservoir, this area is expected to attain the rate of population increase equal to that of the urban area of the State. This is an average increase of 1 per cent per annum compounded, which is a little more than half the national rate. Using this rate of growth as a basis, the estimated population for the year 2010 will be as given in Table 1.

Table 1

Populations - Present and Future

	1960 Population**	Projected Population 2010
Coffeyville	17,268	28,500
Parsons	13,820	22,800
Cherryvale	2,800	4,600
Altamont	678	1,100
Mound Valley	570*	800
Edna	400*	720
Valeda	---	500

*Estimated
**Preliminary U. S. Census figures

V. PRESENT WATER SUPPLIES

Coffeyville

The water use trend at Coffeyville for a 30-year period is depicted in Table 2. Coffeyville's present source is the Verdigris River, from two low-head diversion dams. Storage capacity of these dams is unknown, but is believed to be quite small, which means the city must virtually rely on natural flow of the stream.

Table 2

Water Consumption - Coffeyville, Kansas*

Year	MGD Average
1930	1.92
1940	2.54
1955	3.96
1956	3.90
1957	3.80
1958	2.92
1959	3.02

*Source: Kansas Water Resources Board

The Kansas Government Journal, May, 1959, stated that the water used by industry in the Big Hill area is 30 per cent of the total usage. The Coffeyville Water Department gave the following as the major users of city water with approximate quantities:

Continental Can Company	0.1 mgd
Castle Packing Company	0.1 mgd
Coffeyville Creameries	0.1 mgd
Cooperative Refinery Company	0.80 mgd

Ozark Smelting	0.5 mgd
Acme Foundry	0.5 mgd
Parkersburg Rig and Reel Company	0.02 mgd

The only firm with an appreciable self-supplied water use is the Cooperative Refinery Company. The refinery is presently using about 3 mgd, of which 0.8 mgd is being supplied by the city of Coffeyville, with the remainder being taken by the company directly from the Verdigris River.

Parsons

The city of Parsons, prior to August, 1959, obtained all of its water from the Neosho River, four miles east of the city. Parsons still retains water rights to the water from the Neosho River, but is limited to approximately three million gallons per day maximum. Because of this limiting requirement and because of the drought conditions in the 1950's, when there were long periods of no-flow conditions, it was seen that an additional water supply source must be secured. The city retained engineers and during the month of August, 1959, a new reservoir on Labette Creek was completed. This reservoir has a safe yield of 7.0 mgd.

Historical use of water at Parsons is shown in Table 3.

Table 3

Water Use - Parsons, Kansas

Year	MGD Average
1930	1.82
1940	2.14
1950	1.71
1951	1.59
1952	2.28
1953	1.95
1954	1.70
1955	1.32
1956	1.33
1957	1.04
1958	1.01

Cherryvale

Cherryvale takes its raw water from the Verdigris River about 7.5 miles west of the city. The water system was built in 1911 and is badly in need of renovation. The filtration plant was designed for 1.38 mgd. Raw water pumping facilities and high service pumps are capable of delivering 1.87 mgd to the users. No water consumption records are available.

Altamont

The city of Altamont does not maintain daily water consumption records. However, they do have annual pumping records. The 1958 pumping record showed that 12.3 million gallons of water had been pumped during that year. This would average 34,300 gallons per day or 51 gallons per capita per day based upon the 1958 population. In addition to the normal population of Altamont, there are two consoli-

dated county schools with a combined enrollment of 950 students. These two schools have used as much as 200,000 gallons per month, or seven gallons per capita per day. Water supply sources are two ponds with a combined storage volume of about 41 million gallons.

Edna

The existing water system was placed in service in 1955. Its source is a 12-acre pond on a branch of Bush Creek. The filter capacity is 138,000 gallons per day. Current consumption averages an estimated 30,000 gallons per day. This would indicate that the Edna system is adequate for the present purposes and should be adequate for many years to come, barring unanticipated growth.

Mound Valley

This town secures its water from Pumpkin Creek, which is on the eastern town limit. Storage is secured from two dams, the newest being built about five years ago. Reports give no indication of any water shortage since the second dam was constructed. The water plant operator indicated only periodic difficulty with color.

Ground Water

Ground water supplies in the lower Verdigris River basin (which includes Big Hill Creek) are inadequate to supply the demands of even one large water user. Use of the limited supply of ground water has been further restricted because of quality. Except for

the source in the alluvium along the streams, which contain very limited quantities, the ground water is normally highly mineralized. As a result, municipalities, industries, and rural users rely almost entirely on surface water. Individual farms use cisterns, farm ponds, and shallow wells. During periods of low rainfall, municipalities and industries have been forced to curtail use of water and in some instances haul water to meet minimum needs.

VI. FUTURE WATER NEEDS AND POTENTIAL SOURCES

Table 4 summarizes the projected water needs and potential sources for the three principal cities of the study area. Discussion of each city follows.

Coffeyville

The present source for Coffeyville, as well as for self-supplied local industry, is deficient from the standpoint of dependability. Along with other users in the region who rely largely on the natural flow of streams, they have experienced shortages during low-flow periods. Its location downstream from Big Hill Creek Reservoir makes it advantageous for Coffeyville to consider utilizing storage in the project, either as substitute or supplement to the Verdigris River. The projected requirement of 7.6 mgd includes industry, on the assumption that industries would, in the future, obtain their water through the city because of greater reliability.

Parsons

The city of Parsons in the year 1959 built a reservoir on Labette Creek which has a firm yield of 7.0 mgd. This, together with the 3.0 million gallons water rights that Parsons holds on the Neosho River, should supply the estimated population of 22,800 through the year 2010, unless some major water user comes into this community. Officials of Parsons have expressed an interest in attracting industry and have, therefore, stated that they would be interested in storage in Big Hill Reservoir capable of yielding 3.0 mgd.

Table 4

Projected Water Requirements

Town	2010 Population	2010 Water Needs			Present Supply		Potential Need From Big Hill Creek Reservoir
		Municipal		Industrial	Source	Yield	
		gpcd	mgd	mgd		mgd	
Coffeyville	28,500	160	4.6	3.0	Verdigris River, low-head dams	Unknown	7.6
Parsons	22,800	160	3.7	3.0	Labette Creek impoundment	7.0	0.0
Cherryvale	4,600	160	0.7	0.5	Verdigris River (no lake)	Probably zero	1.2
					Total		8.8

Cherryvale

Although its filtration plant (if renovated) could supply 1.38 mgd, and the pumping facilities are capable of delivering 1.87 mgd of water, Cherryvale does not have a dependable source capable of supplying sufficient water. They feel that they should go to a source which is more dependable than the Verdigris River, and for this reason have indicated that, when Big Hill Reservoir water is available, they desire to take their entire supply from this source.

Smaller Communities

Other communities which were considered in this study and have expressed interest in water supply from the project, are Altamont, Mound Valley, Edna, and Valeda, Kansas. As previously mentioned, Mound Valley has existing local impoundments which should be sufficient to meet present and future needs. Under currently foreseeable conditions, it is believed that each of these towns could best meet its water supply needs by impoundments closer to it than the Big Hill Creek Reservoir. Transmission costs, for the small quantities required, would probably preclude their use of storage in the project.

VII. WATER QUALITY CONSIDERATIONS

No long-term record of the quality of water in the Big Hill Creek at Cherryvale exists. The only available water quality information for Big Hill Creek is from a sample taken by the Public Health Service on November 16, 1958. Analysis of this sample is shown in Table 5. A single observation of the chemical quality of the streams is of limited value in predicting the quality of water that would be stored in an impounding reservoir constructed at the stream point under study. Nevertheless, the analysis in Table 5 is an indication that the quality of water, even at this low discharge, is not objectionable except possibly in hardness (239 ppm). The chloride content compares favorably with waters of the Neosho River at Parsons.

Table 5

Water Quality - Big Hill Creek at Cherryvale
November 16, 1958

Discharge	0.5 cfs
Total alkalinity	192 ppm
pH	7.5
Total dissolved solids	386 ppm
Specific conductance micromhos/cm.[3]	1,880
Total nitrogen	0.48 ppm
Sulfate	17.0 ppm
Calcium	70.0 ppm
Magnesium	16.0 ppm
Total hardness	239.0 ppm
Chlorides	58.9 ppm
Selenium	0.003 ppm
Total phosphates	0.335 ppm
Chromium	0.006 ppm
Fluorides	0.05 ppm
Zinc	0.024 ppm
Cadmium	0.001 ppm

Records of water quality over longer periods of time are available at the Verdigris River at Independence and the Neosho River at Parsons. These two points are fairly close to the Big Hill Creek at Cherryvale, and so the water quality should be somewhat similar. Tables 6 and 7 summarize water quality data available for these two streams.

The chloride content of the Verdigris River on January 17, 1956, as shown in Table 6 has reached as much as 239 ppm, which is somewhat less than the recommended limit of 250 ppm set by the Public Health Service Drinking Water Standards. Water of this quality would not be objectionable for most industrial and municipal purposes.

Water in the Neosho River at Parsons is considerably better. It should be noted that when the discharge was 952 cfs, May 2, 1957, the resultant chloride content was 15 ppm; but when the flow of the river dropped to 61 cfs on March 28, 1957, the chloride content went as high as 84 ppm.

This saline pollution is expected to be rectified. The State of Kansas has an excellent stream pollution abatement program which will, in a very few years, compel all the oil producers in this area to reinject all salt brines to the oil-bearing strata. As a result of this program, the salt content of both the Verdigris River at Independence and the Neosho River at Parsons may be expected to be reduced to the levels which prevailed in 1907 before oil operations were begun. At that time records show that the chloride content of

these two streams was less than 20 ppm. Oil operations on the Big Hill Creek watershed, although not extensive, would have an effect upon the quality of water that would be stored in the Big Hill Creek Reservoir. This water is expected to improve in quality along with the waters of the Verdigris and the Neosho Rivers.

Table 6

Water Quality - Verdigris River, Independence, Kansas

Date	Discharge cfs	Fe	Mn	pH	Ca	Mg	HCO_3	SO_4	Cl	NO_3	Hardness Total	Total Alk.
10-26-56	14	0.35	0.07	7.7	81	12	167	42	208	1.3	252	137
11-20-56	1.7	0.14	0.00	7.7	81	17	171	56	231	0.2	272	140
12-17-56	12	0.08	0.00	7.6	85	17	176	53	239	0.7	282	144
1-31-57	8.2	0.08	0.00	7.9	86	19	190	47	229	0.5	292	156
2-27-57	8.8	0.19	0.00	7.8	72	16	176	35	174	1.0	245	144
3-29-57	17	0.37	0.17	7.6	63	10	161	29	139	0.8	198	132
4-24-57	3,880	----	0.56	7.4	49	8.8	110	29	103	7.5	158	90
5-23-57	5,530	----	----	7.2	47	7.9	127	26	61	8.0	150	104
6-26-57	6,020	1.6	0.00	7.8	51	8.0	139	19	59	4.4	160	114
7-23-57	182	0.53	0.11	7.8	79	13	205	39	105	2.5	250	168
9 -5-57	6.0	0.25	0.20	7.7	57	12	163	25	84	0.8	192	134
9-26-57	278	0.77	0.07	8.0	92	15	220	38	177	1.9	291	180
12-3-57	238	0.37	0.08	7.8	87	14	212	40	146	2.2	274	174
12-23-57	138	0.30	0.13	7.9	96	18	242	49	143	2.8	314	198
1-29-58	876	----	----	8.1	112	21	250	65	209	2.7	366	205
4-9-58	1,600	----	----	7.8	78	11	215	42	69	5.3	240	176
4-29-58	940	----	----	7.8	82	13	220	47	89	4.9	258	180
5-27-58	269	----	----	7.9	96	15	271	47	116	2.2	301	222
6-25-58		----	----	7.6	41	8.3	132	16	48	2.8	136	108
7-28-58		----	----	7.5	59	11	173	30	72	2.9	192	142
8-25-58		----	----	7.9	98	17	305	44	111	2.7	314	250
9-29-58		----	----	7.9	61	10	183	28	62	2.2	193	150
11-3-58		----	----	7.6	96	15	289	43	111	0.7	301	237
12-1-58		----	----	7.7	76	14	212	33	94	1.5	247	174
12-29-58		----	----	8.0	109	18	283	44	162	1.5	246	236
2-3-59		----	----	8.1	110	24	261	53	247	1.0	373	214

Table 7

Water Quality - Neosho River, Parsons, Kansas

Date	Discharge cfs	Fe	Mn	pH	Ca	Mg	HCO_3	SO_4	Cl	NO_3	Hardness Total	Total Alk.
10-26-56	0.0	0.67	0.12	7.9	51	6.6	156	28	89	1.6	154	128
11-27-56	0.0	0.32	0.09	7.7	49	8.8	161	27	83	2.0	158	132
12-27-56	0.0	0.24	0.02	7.6	49	8.8	161	29	80	1.8	158	132
2-4-57	0.0	0.20	0.00	7.8	49	9.7	161	31	81	1.5	162	132
2-27-57	0.0	1.9	0.13	7.7	37	6.7	120	28	94	1.8	120	98
3-28-57	6.1	0.87	0.00	7.7	41	6.2	123	31	84	2.7	128	101
5-2-57	952	2.2	0.27	7.6	36	9.2	123	38	15	7.1	128	101
5-29-57	3,550	3.4	0.20	7.5	47	10	142	40	27	7.5	158	116
7-31-57	916	0.33	0.08	7.6	69	18	176	100	38	2.0	246	144
10-1-57	172	1.1	0.15	7.8	41	12	124	38	19	4.9	152	102
10-30-57	530	2.0	0.17	7.7	49	10	154	51	18	2.6	164	126
12-4-57	388	0.90	0.17	7.6	64	13	193	57	26	3.5	213	158
12-30-57	495	0.48	0.07	7.6	76	13	227	53	34	4.9	243	186

VIII. VALUE OF STORAGE

Preliminary studies by the Corps of Engineers indicate that the optimum storage for water supply in Big Hill Creek Reservoir is that which would assure a yield of 4.5 mgd. The provision of this storage would help to meet the need for additional dependable supplies, projected to reach about 8.8 mgd by the year 2010, as shown in Table 4.

The value of water supply storage in the Big Hill Creek Reservoir has been calculated by using as an alternative the cost of building a single-purpose water supply reservoir, at the same location as the proposed multi-purpose site on Big Hill Creek. The cost of building this single-purpose reservoir, together with other pertinent information, is as follows:

Total storage	18,100 ac. ft.
Water supply storage	17,000 ac. ft.
Firm yield	4.5 mgd
Construction cost *	$2,120,000
Annual capital cost **	$ 82,500
Annual operation and maintenance	$ 12,700
Cost per 1,000 gallons	5.8 cents

From the above it is concluded that the value of water supply storage for municipal and industrial use in the multi-purpose Big Hill Reservoir is 5.8 cents per 1,000 gallons.

* Based on 1960 prices.

** Assuming a 50-year repayment period and 3 per cent interest rate.

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